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Georg KÄMMLER

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For: HEAT EXCHANGER

TRANSLATOR'S DECLARATION

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

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Date: August 12, 2004

Name: N. T. SIMPKIN

For and on behalf of RWS Group Ltd

Heat Exchanger

The invention relates to a heat exchanger having at least one tube through which a first medium can flow and which at a first end region is connected to a first terminating element and at a second end region is connected to a second terminating element. A heat exchanger of this type is particularly suitable for use as an exhaust-gas heat exchanger, although it can also be used to cool other media.

Exhaust-gas heat exchangers are known, for example, from DE 196 54 368. In exhaust-gas heat exchangers in accordance with DE 196 54 368, exhaust gas flows through a plurality of tubes. These tubes are surrounded by a tubular casing, through which a coolant flows in order to cool the exhaust gas.

DE 296 22 411 has disclosed an exhaust-gas heat exchanger in which a plurality of inner tubes are connected to tube plates, and an outer casing is connected to them, it being possible for a coolant to flow between the outer casing and first tubes.

Heat exchangers of this type have the drawback that in view of the temperature differences between the exhaust gas flowing through the inner tubes and the coolant temperature, the inner tubes undergo significantly greater thermal expansion than the outer tube, and consequently the thermal cycles resulting from heating and cooling of the heat exchanger lead to cracks in the tube plates.

It is an object of the invention to improve exhaust-gas heat exchangers in accordance with the prior art in such a manner that the heat exchangers can be produced easily and inexpensively yet nevertheless cracks caused by differing thermal expansions of the inner tubes and

outer casing do not occur over a prolonged operating time.

According to the invention, this is achieved, in the case of a heat exchanger as described above, by virtue of the fact that a first and a second tube part or a tube-like part is respectively connected to the first and second terminating elements, the two tube parts running radially into one another at least over a partial region of their axial extent, with at least one sealing element in the spatial region between the tube parts.

It is particularly expedient if at least one chamber is formed between the first tube part and the second tube part. The word between advantageously means in the spatial region between the two tube parts. This may advantageously relate to the radial orientation and/or the axial orientation. This chamber expediently serves to receive a sealing element. It is also particularly expedient if the at least one chamber is formed by the first tube part and the second tube part.

Furthermore, it is advantageous if the at least one chamber has at least one substantially ring-like, radially protruding or extended element or is delimited thereby. In this case the chamber is delimited by the inner or outer wall of the tube parts and at least one ring-like element.

It is particularly advantageous if the at least one chamber has at least two elements which protrude radially substantially in the style of rings and are arranged spaced apart from one another in the axial direction. This makes it possible to define a chamber which is preferably annular in form. However, it may also be possible to divide the chamber into ring segments, as seen in the circumferential direction, by accommodating or forming axial webs.

Furthermore, it is expedient if at least one element which protrudes radially in the style of a ring is an integral constituent of one of the tube parts. In this context, it may also be advantageous to provide a plurality of ring-like parts, these ring-like parts then if appropriate also being connected to in each case one tube part.

It is also advantageous if the elements which protrude in the style of rings are formed integrally with one tube part and/or the other tube part.

According to another exemplary embodiment, it is expedient if at least one element which protrudes in the style of a ring is an additional component which is arranged between one tube part and the other tube part and if appropriate is connected to one tube part or the other tube part.

In this context, in one exemplary embodiment it may be advantageous if the chamber is at least substantially sealed off by the ring-like elements. In another exemplary embodiment, it is advantageous if the chamber is substantially not sealed off by the ring-like elements.

Furthermore, it is expedient if the elements which protrude in the style of rings serve as a support for the tube parts, as seen in the radial direction. This advantageously makes it possible to ensure that the tube parts do not tilt with respect to one another. It is also expedient if the elements which protrude in the style of rings serve as axial bearings. This allows the two tube parts to be displaced or to move at least slightly with respect to one another, which may be caused by the thermal expansion in the event of temperature differences.

It is particularly expedient if the chamber is at least partially filled with an elastic means. Furthermore, it is expedient if the chamber is filled in such a manner that a ring-like element is formed from the elastic medium in the chamber, extending between the radially inner tube part and the radially outer tube part. This ring-like element may only be formed when the medium is introduced into a chamber.

In another exemplary embodiment, it is also advantageous if the elastic element can be laid into a chamber as a ring element.

It may also be advantageous if the elastic element can be introduced into the chamber as a pasty or gel-like medium.

It is particularly expedient if a plurality of passages or tubes, through which a first medium flows, are arranged substantially parallel to one another, radially inside tube parts.

In this context, it may also be expedient if the plurality of tubes are each connected, at their first end region, to a first terminating element and are each connected, at their second end region, to the second terminating element.

Furthermore, it is expedient if the at least one tube through which a first medium flows is connected, at at least one end region, to a connection element for supplying and/or discharging a first medium.

It may also be expedient if at least one terminating element is connected to at least one connection element for supplying and/or discharging a first medium.

Furthermore, it is expedient if the tube parts which are connected at the respective terminating elements,

with elastic means provided in the chamber, form a substantially sealed spatial region, with at least two connection elements being provided and it being possible for a second medium to flow through the spatial region through the connection elements.

It is particularly advantageous if the second medium flows around the tubes through which the first medium flows.

In the text which follows, the invention is explained in detail on the basis of an exemplary embodiment and with reference to the drawing, in which:

Fig. 1 shows part of a heat exchanger,
Fig. 2a shows a partial view of a heat exchanger,
Fig. 2b shows a partial view of a heat exchanger,
Fig. 3a shows a partial section through a heat exchanger,
Fig. 3b shows a partial section through a heat exchanger,
Fig. 4a shows a partial section through a heat exchanger,
Fig. 4b shows a partial section through a heat exchanger, and
Fig. 5 shows a partial section through a heat exchanger.

Fig. 1 at least partially shows a heat exchanger in which a plurality of tubes 2 through which a first medium can flow are provided. According to the exemplary embodiment, these tubes are arranged in rows, with a plurality of rows of tubes in turn being arranged next to one another. However, according to a further exemplary embodiment, it is also possible to provide at least just one tube or for a plurality of these tubes to be arranged in a different configuration.

The tubes 2 are preferably made from metal, such as for example from aluminum or stainless steel. However, the tubes may also be produced from another material which is suitable for ensuring heat transfer from the medium flowing through the tube to a further medium. Depending on the particular application, these tubes may also, for example, be made from plastic.

The tubes 2 have a first end region 2a and a second end region 2b, which are each arranged at their two axial end regions. By means of these end regions, the tubes are respectively connected to a first terminating element 3 and a second terminating element 4.

The terminating elements advantageously have planar regions into which windows are introduced. The terminating elements are connected to the tubes 2 in such a manner that the medium which flows through the tubes 2 can emerge through the windows in the terminating elements, and the tubes, at their end regions, are tightly connected to the window frames of the terminating elements. This is expediently effected by welding or soldering or by another securing or joining process.

According to the invention, a casing 5 is arranged around the tubes 2, although only part of this casing can be seen in Figure 1. This casing, which is connected in a sealing manner to the terminating elements at its respective two end regions, also provides connection elements 6, 7, through which a second medium can flow, in such a manner that the medium can flow into the spatial region around and/or between the tubes 2, in the direction indicated by arrow 8, and can flow onward in this region, as indicated by the arrows 9, before being able to flow out through the connection 7 as indicated by the arrow 10.

It is expedient for further connection elements to be provided at the terminating elements 3 and 4, serving to pass first medium flowing through the tubes 2 to the heat exchanger and to discharge this medium from the heat exchanger. However, these connection elements are likewise not illustrated in Figure 1.

Figures 2a and 2b each show parts of a heat exchanger 100, although the central tube/fin block 101 is not illustrated in full. In this connection, however, reference is made, by way of example, to Figure 1. Figure 2a shows a connection element 110 which has two connection stubs 111 and 112. A first medium, such as for example an exhaust gas in the case of an exhaust-gas heat exchanger, flows into or out of the heat exchanger, depending on the arrangement of the heat exchanger in the flow of the first medium, through these connection stubs 111 and 112.

The connection element 110 is connected to the terminating element 120, the terminating element being connected to the tubes 101, as has already been explained in connection with Figure 1.

Two tube parts 130 and 131 are arranged radially outside the at least one tube 101 or radially outside the tubes 101. In this case, the first tube part 130 is expediently connected in a sealed manner to the terminating element 120. Furthermore, the first tube part 130 has an opening, through which the second medium can flow into the heat exchanger and/or out of the heat exchanger. It is expedient for a connection element, such as tube connection stub 140, to be connected to the second tube part 131 in order to supply and/or discharge this medium. If the components are made from stainless steel, it is expedient for connections to be effected by means of welding processes. By way of example, the connection element 110 can be connected to the terminating element 120, or

the tube connection stub 140 can be connected to the first tube part 130, by means of the weld seams 121 and 132, respectively. The first tube part 130 may advantageously be designed as a round tube or as a polygonal tube. The choice of geometry of the first tube part, as seen in cross section, advantageously depends on the arrangement of the tubes 101 in the interior of the first tube part. The second tube part 131 can adopt a corresponding geometry.

The second tube part 131 is designed in such a manner that it is connected at one end region to a terminating element 122, with a connection element, such as tube connection stub 141, also being connected to the tube part 131. In the region of the connection element 141, the tube part 131 expediently has an opening for the second medium to flow in or out.

Furthermore, a connection element 115, which has a tube connection stub 116 for the first medium to flow in or out, is connected to the terminating element 122.

According to the invention, it is expedient if the axial extent of the first tube part and the axial extent of the second tube part are dimensioned in such a manner that over a partial region of the axial extent of the heat exchanger part of the first tube part is arranged radially outside part of the second tube part. Therefore, in this partial region of their radial extents, the two tube parts are arranged so as to run radially into one another.

Furthermore, it can be seen from Figure 2a that a sealing element 150 is provided in the region in which the two tube parts 130 and 131 run radially into one another over a partial region of their axial extent.

This sealing element 150 is designed in such a manner that the two tube parts 130 and 131 can move in the

axial direction at least to a slight extent relative to one another, yet nevertheless the spatial region radially inside the tube parts is sealed off by the seal.

Furthermore, the first tube part 130 or the second tube part 131 has elements which protrude in the radial direction and are designed in such a manner that tilting of the two tube parts relative to one another is as far as possible prevented. For this purpose, the elements which protrude in the radial direction, such as for example rings 160 and 161, are advantageously dimensioned in such a manner that they touch or virtually touch the respective other tube part and in so doing form a seal or do not form a seal, as appropriate.

Figure 3a shows this in more detail. The tube part 130 is expediently connected in a sealing manner, by a weld seam 201, to the terminating element 120 along the circumference of terminating element and tube part. Furthermore, the connection stub 140 is connected to the tube part 130.

In the exemplary embodiment shown in Figure 3a, the first tube part 130 is radially outside the second tube part 131. However, in another exemplary embodiment this arrangement may also be reversed.

Two elements which protrude in the radial direction are connected to the second tube part 131 by virtue of being formed integrally with it, such as 160 and 161. A chamber 170 is formed between the first tube part and the second tube part in the spatial region between the first tube part 130 and the second tube part 131 and between the elements 160 and 161 which protrude in the radial direction.

A sealing element is advantageously introduced inside the chamber 170.

In another exemplary embodiment of the invention, however, it may also be expedient to provide at least only one element which protrudes in the radial direction or to provide a plurality of such elements, such as for example three or more such elements, so that as a result, by way of example, a plurality of chambers or spatial regions arranged between the first and second tube parts are also formed.

The elements 160 and 161 are advantageously formed as ring-like elements which protrude in the radial direction.

In this context, it may be expedient if these ring-like elements are an integral constituent of one tube part or the other tube part, are connected thereto or are arranged as additional components between these tube parts.

The elements which protrude in the radial direction serve on the one hand to define a chamber and may on the other hand also be used as a support for the tube parts acting in the radial direction. This is particularly expedient if at least two such elements 160 and 161 are provided, and these elements are spaced apart from one another, so that, given suitable dimensioning of these elements compared to the other tube part, tilting of the respective tube parts with respect to one another is limited or reduced.

A sealing element can be introduced into the chamber 170. This element may be formed as an elastic element, for example from an elastomer, silicone or another material. The elastic element may be introduced into this spatial region as a prefabricated ring-like element or, according to a further exemplary embodiment

of the invention, may also be introduced at a subsequent time, following assembly of the two tube parts, through openings made in the radially outer tube part. A filling (introduction) operation of this type may, for example, be effected by injection. In this case, it may quite easily be expedient for at least one, but advantageously a plurality of, openings to be provided at the outer circumference of the radially outer tube part, through which the elastic means is introduced into the spatial region.

It may also be particularly expedient for the chamber 170 not to be completely filled by the elastic means, but rather to be only partially filled by it. Under certain circumstances, this has the advantage that the elastic medium is not destroyed by shear forces on account of the axial displaceability of the two tube parts 130 and 131.

The elastic means may expediently be introduced in such a manner that the elastic means can be introduced into the chamber as a pasty or gel-like medium.

The means may also be arranged in such a manner that the means is arranged as a prefabricated element. In this case, it may preferably be prefabricated and arranged as a ring-like element.

Figure 4 shows a modification to the arrangement of the elastic element shown in the previous figures, in which the end regions of the chamber are formed by ends of the tube parts 201, 202 which protrude radially inward and radially outward, respectively, and as a result the elastic element 203 can be placed under axial prestress between these protrusions, which advantageously run all the way around in the radial direction.

In accordance with Figure 4b, as a modification to the previous figures, the elastic element may also be

fitted or arranged between two tube parts 211, 212 which do not have projections in the radial direction, in order to define a chamber. The elastic element 213 is preferably arranged in such a way that it adheres to the two tube inner or outer walls, so that it is arranged so as to form a seal.

Figure 5 shows a further exemplary embodiment of two tube parts 250, 260 which run radially outside one another over a partial region of their axial extent. The tube part 250 is arranged radially inside the tube part 260. The tube part 260 has a region 261 which protrudes radially outward and thereby forms a free space for forming a space to receive a sealing element. The tube part 250 has the radially inwardly protruding region 253, which together with the region 261 forms the chamber for receiving the sealing element. Furthermore, radially outwardly protruding regions are arranged on the element 250 and are or can be used for support on the radially outer tube part, so that the tube parts cannot tilt relative to one another. These supporting elements 4 may, however, also be arranged on the radially inner and/or outer tube part.